MODIS Semi-annual Report (July 2001 – December 2001)

Bo-Cai Gao, Ping Yang, Seon Park, and Y. Chu

(This reports covers the MODIS **cirrus characterization and correction** algorithm and part of the MODIS **near-IR water vapor algorithm**)

Main topics addressed in this time period:

1. **MODIS near-IR water vapor algorithm**:

In May of 2001, we generated new lookup tables for the MODIS near-IR water vapor algorithm. The new tables were calculated using the recently available HITRAN 2000 water vapor line parameters and line-by-line atmospheric transmittance codes. The updated MODIS near-IR water vapor algorithm has been used in the MODIS operational computing environment since late May of 2001. With the new lookup tables, our previous problem of overestimating water vapor amount from MODIS data is largely resolved.

During this time period, we made major efforts in analyzing the Level 3 MODIS near-IR water vapor products, trying to understand the seasonal variations of total precipitable water vapor in different geographical regions. We have seen that the eastern part of US in the summer months is affected by the moistures originated from the Atlantic Ocean. The middle portion of the US (east to the Rocky Mountains) is largely affected by the moisture from the Gulf of Mexico. The Indian Continent is affected by moistures from two different sources in different seasons. Mountains are very effective in blocking the horizontal movement of water vapor. We feel that the MODIS near-IR water vapor products can be used for hydrological related research, particularly over land areas. During this time period, we made comparisons between the MODIS near-IR and IR water vapor products. Large differences between the two products over desert areas are present. We also made comparisons between MODIS near-IR water vapor values and the DOE Microwave Radiometer water vapor values over the Southern Great Plain in Oklahoma. In the coming months, we will make similar comparisons between two sets of water vapor data over a site in Alaska and an island site in the Pacific Ocean. We will also use radiosonde data to check the possible drift in radiometric calibrations of ground-based microwave radiometers.

2. **MODIS cirrus reflectance algorithms**:

In May of 2001, we delivered an operational version of PGE06CD code to the MODIS Project. The code was different from the previous deliveries in terms of algorithm and code implementation. The code retrieved cirrus clouds on the basis of MODIS visible 0.66-μm and 1.38-μm bands. The basic principle for the algorithm is to derive the transmittance for the water vapor above cirrus that is normally located at an altitude of 8 km or higher. The true cirrus reflectance is obtained from the 1.38-μm band data by scaling the water vapor absorption using the water vapor transmittance.

During this time period, we further improved the PGE06CD code. Specifically, the implementation of the portions of the algorithm for finding slopes in the scatter-plot of MODIS 1.38-μm radiance versus 0.66-μm radiance has been refined. Proper default values have been set in cases of bad input MODIS data or unusually small or large slope values. This version of the code has gone through rigorous testing with real MODIS data sets acquired over a few days. An updated version of PGE06CD was delivered to MODIS SDST in November of 2001. The code has already passed the integration and testing at SDST, and is ready to be switched to the operational computing environment.

During this time period, we made extensive analysis of the Level 3 MODIS cirrus reflectance data products. Seasonal variations of high cloud reflectivity on the global scale are seen obviously. High mountains located in low latitude regions, such as Himalayas in Asia and Andes in South America, have significant effects in blocking the horizontal movement of water vapor and pushing the moisture up to form cirrus clouds in the upper troposphere. Mountains located at higher latitudes have weaker effects on the generation of upper level cirrus clouds because of smaller amount of water vapor available at the high latitude regions. Due to the lack of major land masses in the latitude range between 45 degree and 65 degree in the southern hemisphere, high clouds are formed in this belt in certain seasons. These clouds can “freely” circulate in the belt. All our observations are preliminary at this stage. Further analysis will be performed in the near future.

During this time period, we compared MODIS level 2 and Level 3 aerosol products with the cirrus reflectance products. Thin cirrus cloud scattering effects were not completely screened out in the MODIS aerosol products. We have helped to find a ratio technique (1.38-micron channel / 1.24-micron channel) to properly separate the high level thin cirrus clouds from the lower

level aerosols and dusts. The ratio technique will be implemented in the MODIS aerosol algorithm.

3. **Radiative Transfer Modeling**:

Ping Yang has always been studying the scattering properties of cirrus particles. He is now investigating the bi-directional ice particle scattering effects for two MODIS channels – one at 1.38 micron and the other at 0.645 micron.

4. **Other Services and Discussions**

Gao participated the AGU Fall Meeting in San Francisco in early December. He also participated the MODIS Atmosphere Group Meeting and the MODIS Science Team Meeting in the middle of December.

During this time period, Dr. Ping Yang left for the Texas A&M University to take an assistant professor position. Dr. Seon Park left for S. Korea to take a professor position in a university. Their experiences in the analysis of MODIS data partially helped them in obtaining the university faculty positions.

5 **Publications**:

Gao, B.-C, P. Yang, W. Han, R.-R. Li, and W. J. Wiscombe, An Algorithm Using Visible and 1.38-µm Channels to Retrieve Cirrus Cloud Reflectances From Aircraft and Satellite Data, submitted to IEEE Trans. Geosc. Remte Sensing.

Yang, P., B.-C. Gao, and coauthors, 2001, Inherent and Apparent Scattering Properties of Coated or Uncoated Spheres Embedded in an Absorbing Host Medium, Appl. Opt. (accepted for publication).

Yang, P., B.-C. Gao, and coauthors, 2001: Asymptotic solutions for optical properties of large particles with strong absorption, *Appl. Opt*. 40, 1532-1547.

Yang, P., B.-C. Gao, and coauthors, 2001: Radiative properties of cirrus clouds in the infrared (8-13 µm). *J. Quant. Spectrosc Radiat Transfer*., 70, 473-504.

Yang, P., B.-C. Gao, and coauthors, 2001: Sensitivity of cirrus bidirectional reflectance at two MODIS Bands to vertical inhomogeneity of ice crystal habits and size distributions, *J. Geophys. Res.*, 106, 17267-17291.